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ABSTRACT

A study compared pupil reactions to instruction in arithmetic by conventional methods and by programed instruction supplemented by teacher-supervised small group instruction. Subjects were 7th graders from two classes in Malmo, Sweden. Pre- and posttests and bimonthly observations were used to monitor arithmetic achievement, reading ability, classroom behavior, work habits, and attitudes. Results showed no significant difference in achievement or preferences of subjects, but the programed instruction group showed greater improvement in reading instructions and in laboratory behavior. A description of experimental design and tabular summaries of results are provided. (EMH)

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Holmberg, I.:

A COMBINATION OF PROGRAMMED INSTRUCTION AND TEACHER-SUPERVISED SMALL GROUP INSTRUCTION COMPARED WITH CONVENTIONAL CLASSROOM METHOD

No. 10 June 1966

A COMBINATION OF PROGRAMMED INSTRUCTION AND TEACHER-SUPERVISED SMALL GROUP INSTRUCTION COMPARED WITH CONVENTIONAL CLASSROOM METHOD.

Abstract. - This report presents results from a study of pupils' reaction to different kinds of instruction in arithmetic. Two groups of seventh grade pupils were trained in arithmetic, one group by conventional classroom instruction, the other by programmed instruction supplemented by teacher-supervised small group instruction. Changes in certain achievement, attitude and behavior variables as a function of instruction method have been analysed.

I. PROBLEM

Up to now, the impact of technology on education has had a rather small effect. Many audio-visual aids can be produced by our advanced technology: television, films, micro-film, etc., which have proven to be very useful in the educational system. Teaching machines can be used for most instructional activities and in testing for content, in and of itself, or for subsequent guidance. Now we have to investigate more specificially the most practical ways of applying the various effective new techniques.

Studies on programming have included comparisons of different response modes, problems of step size and sequencing, comparisons of different prompting and confirmation methods and problems of branching, pacing and repetition.

Field studies reporting the results of global comparisons of programmed and conventional instruction have appeared. The present report is a summary of a more detailed study (Holmberg, 1966), which aimed at investigating the differences, if any, in performance, attitudes, and behavior between classes with conventional instruction in arithmetic and classes with programmed instruction supplemented by teacher-supervised small group instruction. It is a follow-up study to an earlier investigation (Holmberg, 1965) in which programmed and conventional classroom instruction in arithmetic was compared over three semesters in grades 7 through 8. The main result was that no significant differences in achievement, preferences for the subject, or pupil behavior during the lessons were found, whereas the attitude toward programmed instruction was significantly more negative in grade 8 than in grade 7.

Considering the attitude changes, the exclusive use of programmed material for whole courses seems questionable. Perhaps programming parts of courses would represent a more motivating and convenient way to use this method.

In order to investigate if attitude deterioration could be avoided while still utilizing the same program, this modified form of programmed instruction, i.e., programmed instruction supplemented by teacher-supervised small group instruction, has now been tested. The main objectives of this follow-up study, which also continued over three semesters, have been the following:

1. To investigate possible achievement differences in arithmetic between classes with programmed instruction supplemented by teacher-supervised small group instruction (P1) and classes with conventional instruction (C1).
2. To investigate possible differences in reading ability between P1-classes and C1-classes.
3. To investigate possible differences in observed behavior (working activity, play and passivity, goal-directed interactions, and disturbing interactions) between P1-classes and C1-classes.
4. To investigate possible differences in working habits between P1-classes and C1-classes.
5. To investigate possible differences in preference for arithmetic between P1-classes and C1-classes.
6. To investigate if, and in what respect, the attitude toward arithmetic changes in other ways during P1 than during C1.

II. SUBJECTS

The pupils of two classes at the School of Education in Malmö, Sweden, served as subjects: 19 boys, 17 girls. They were studied during the seventh grade (Fall 1964, Spring 1965) and eight grade (Fall 1965). In order to ascertain whether the two classes, 18 pupils in each, were intellectually comparable, they were both tested with the Cattell Culture Fair Scale 2A. The experimental class (P1) had a mean of 26, 83 with a standard deviation of 6, 81 and the control class (C1) had a mean of 28, 44 with standard deviation of 4, 58. The difference was not statistically significant, $p > 0, 20$. To control for the arithmetical knowledge of the pupils they were given an arithmetic test with ten items

P1-class: $m = 2, 72$, $s = 0, 96$ $p > 0, 20$
C1-class: $m = 2, 83$, $s = 0, 92$

The eighteen pupils from each class were subdivided according to the mathematical and intellectual variables into a high, a middle and a low group, 6 pupils in each.

III. THE PROGRAMMED MATERIAL

The program in arithmetic is a linear one, of the Skinner type, written by Mr. Sven Jansson, Gothenburg, Sweden. The programs are presented in the Swedish teaching machine PIL, sold by IPU (The Institute for Programmed Instruction, Gothenburg, Sweden). The apparatus is based on Skinner´s principles of learning and is similar in function to some of the best known American machines (such as, e.g., Min-Max II).

IV. METHOD

The experimental class received programmed instruction combined with teacher-supervised small group instruction. The control class received conventional instruction: e.g., the teacher prepared new items

on the blaclboard and the pupils were given exercises, first on the blackboard and then individually in the textbooks.

Both the control and the experimental class had the same teacher. In the earlier investigation (Holmberg, 1965), the teacher was instructed to be as passive as possible in the experimental class. In this investigation the teacher was told to motivate the pupils in the experimental class by giving them instruction in small groups at least once a week. Time for group instruction varied from 10 to 20 minutes; group size varied from 2 to 6 pupils. Home exercises were not used in the experimental class, but as a part of the instruction method the control class received home lessons once a week. Arithmetic achievement was measured by teacher-made tests, given once a month.

Changes in reading ability were investigated once a semester with diagnostic reading tests, designed by Dr. Esse Lövgren at the School of Education in Stockholm, Sweden.

Behavior was registered by means of systematic classroom observations twice a month according to a scheme for observation of single pupils. This scheme is a revision of the one used in the earlier mentioned investigation. Categories of activities included are: working activity, play and passivity, goal-directed interactions and disturbing interactions. The observations concern all pupils in the two classes. We used control observers at every occasion in order to determine observer reliability. The mean of agreement between observers was for the experimental class 86% and for the control class 80%. Twelve observers watched the classes every time. A classroom with one-way screens at the School of Education made possible non-disturbing observations of the classroom situation. The observers had been given extra training in observation technique, and in the use of this particular observation scheme.

To find out if the method with programmed instruction had changed working habits, special observations were made during the laboratory exercises in chemistry. After the first experiment with programmed instruction (Holmberg, 1965), the teachers in such laboratory subjects as chemistry and physics were of the opinion that pupils from the experimental class could read instructions better than pupils in the control class. They seemed to begin work more rapidly and they asked the teacher for advice less often. During the Autumn semester 1965, an observer noted the frequency of pupil inquiry in the two classes every fortnight. Once a month, for control puposes, one more observer watched the classes. The mean of agreement between observers was 94%.

Changes in preference for specific arithmetical activities vs. other specific school activities were tested twice a semester with a forced-choice questionnaire, Form H. Further data about attitude changes were gathered by having the pupils answer questions concerning the programmed instruction method.

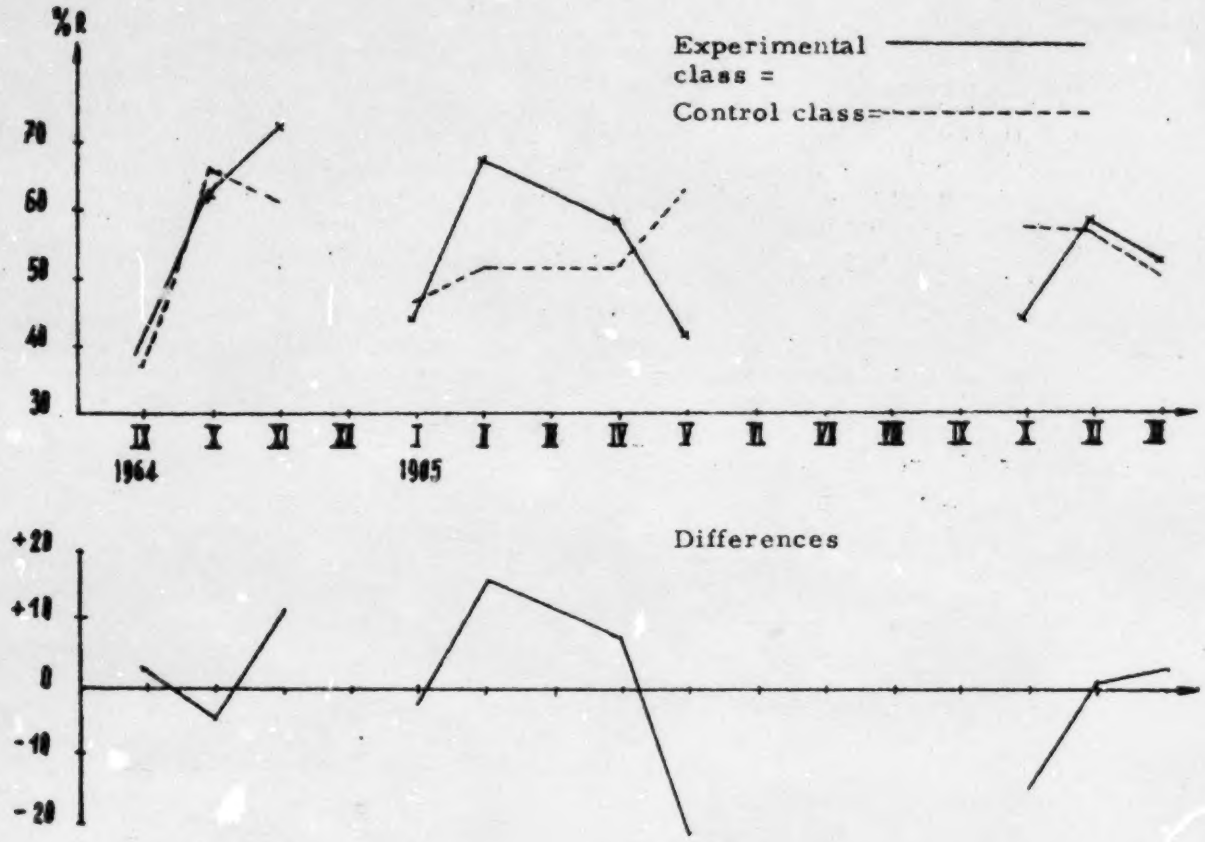
V. RESULTS AND DISCUSSION

The results for the pupils have been subjected to analysis of variance.

A. Analysis of achievement changes in arithmetic (Figure 1)

There are no significant differences in arithmetic achievement between the classes. The variation between high, middle, and low groups is significant. The high group gets the best results, and the low groups the poorest. This is natural, since we deal with achievements of the same kind as that upon which the subdivision into groups had been made. Time development is similar for the two methods.

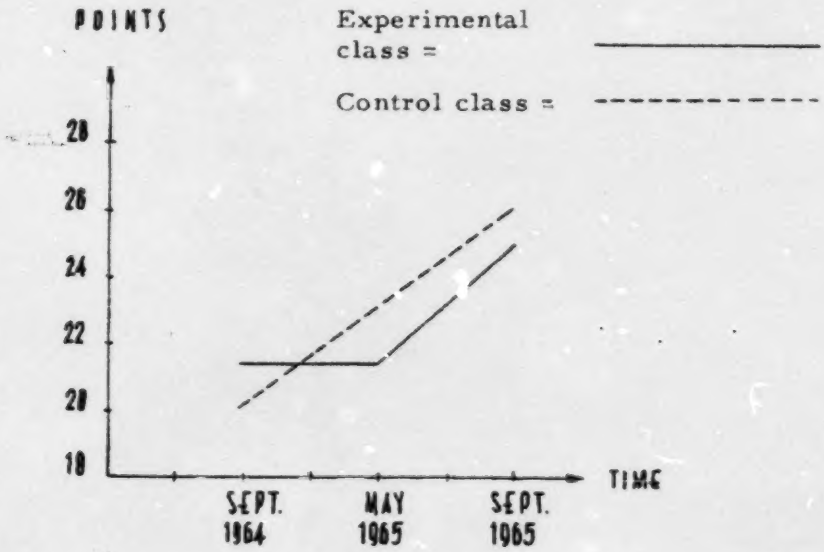
Fig. 1. Differences in arithmetic achievement.



B. Analysis of changes in reading ability (Figure 2)

Both instruction methods yield the same average result in reading ability. Within each group the time development is different for the two methods. During Spring 1965 the experimental class obtained lower mean points. The pupils had decreased their reading speed, gaining better comprehension - a result similar to that in the earlier mentioned investigation concerning programmed instruction. This new reading technique gives a positive result as regards the pupils´ working habits.

Fig. 2. Changes in reading ability.



C. Analysis of classroom behavior (Figures 3-6)

There is a significant difference between the averages for the two methods only in the variable "disturbing interaction". This variable is most frequently noted in the control class. The variation between high, middle, and low groups is not significant in any variable. In all behavior variables there is a significant variation between examinations, more dependant upon an irregular time development than upon a distinct trend.

Fig. 3. Changes in "working activity".

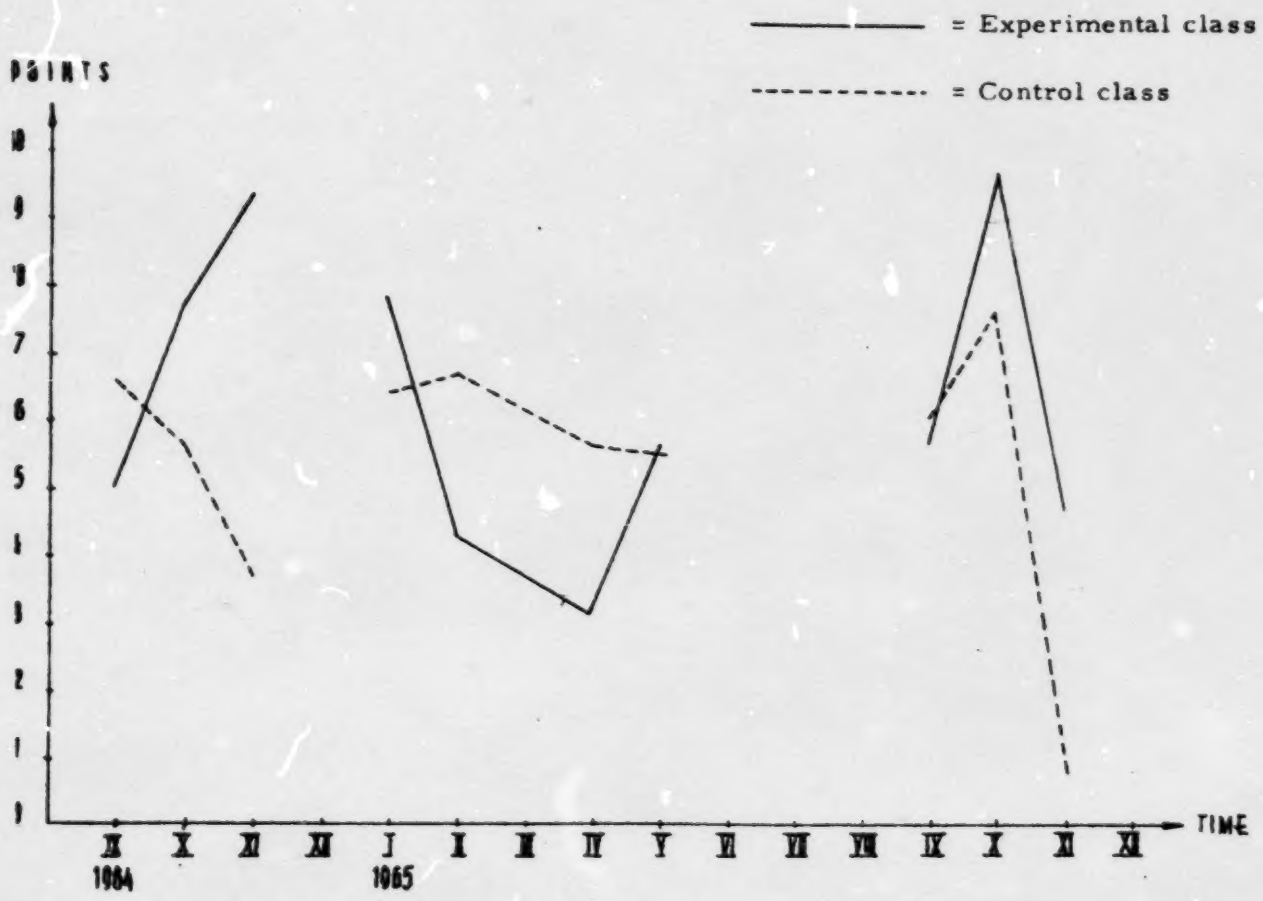


Fig. 4. Changes in "play and passivity".

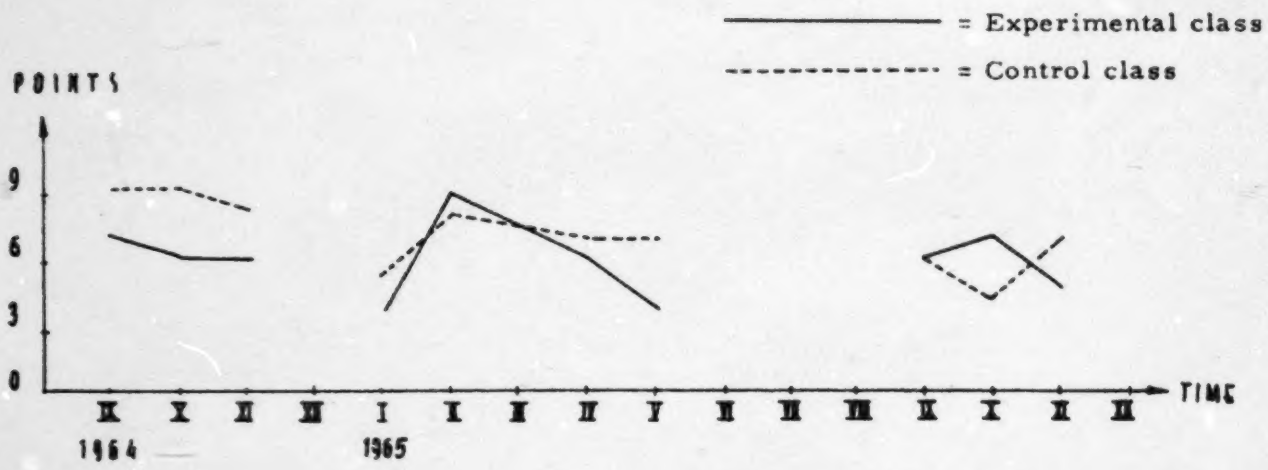


Fig. 5. Changes in "goal-directed interactions".

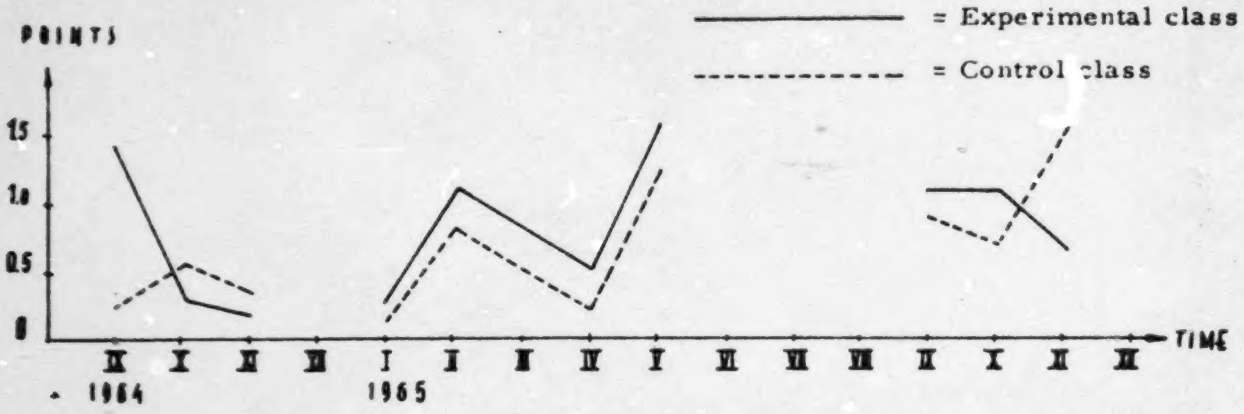
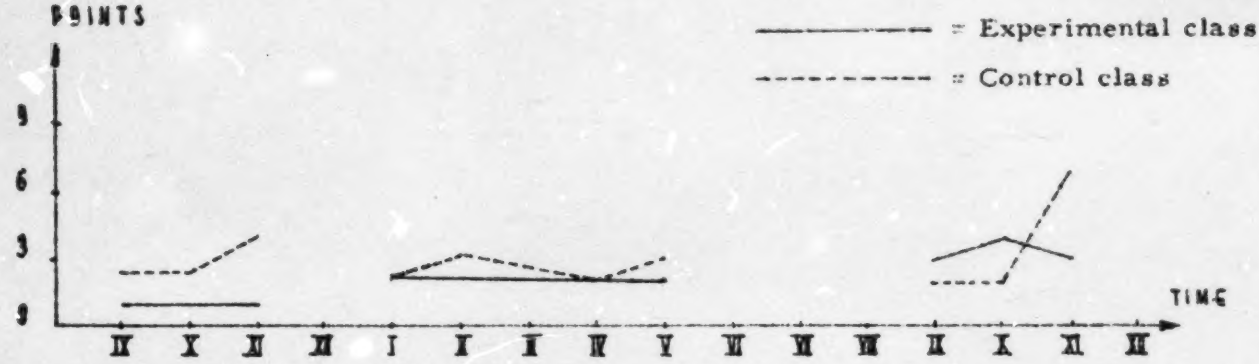
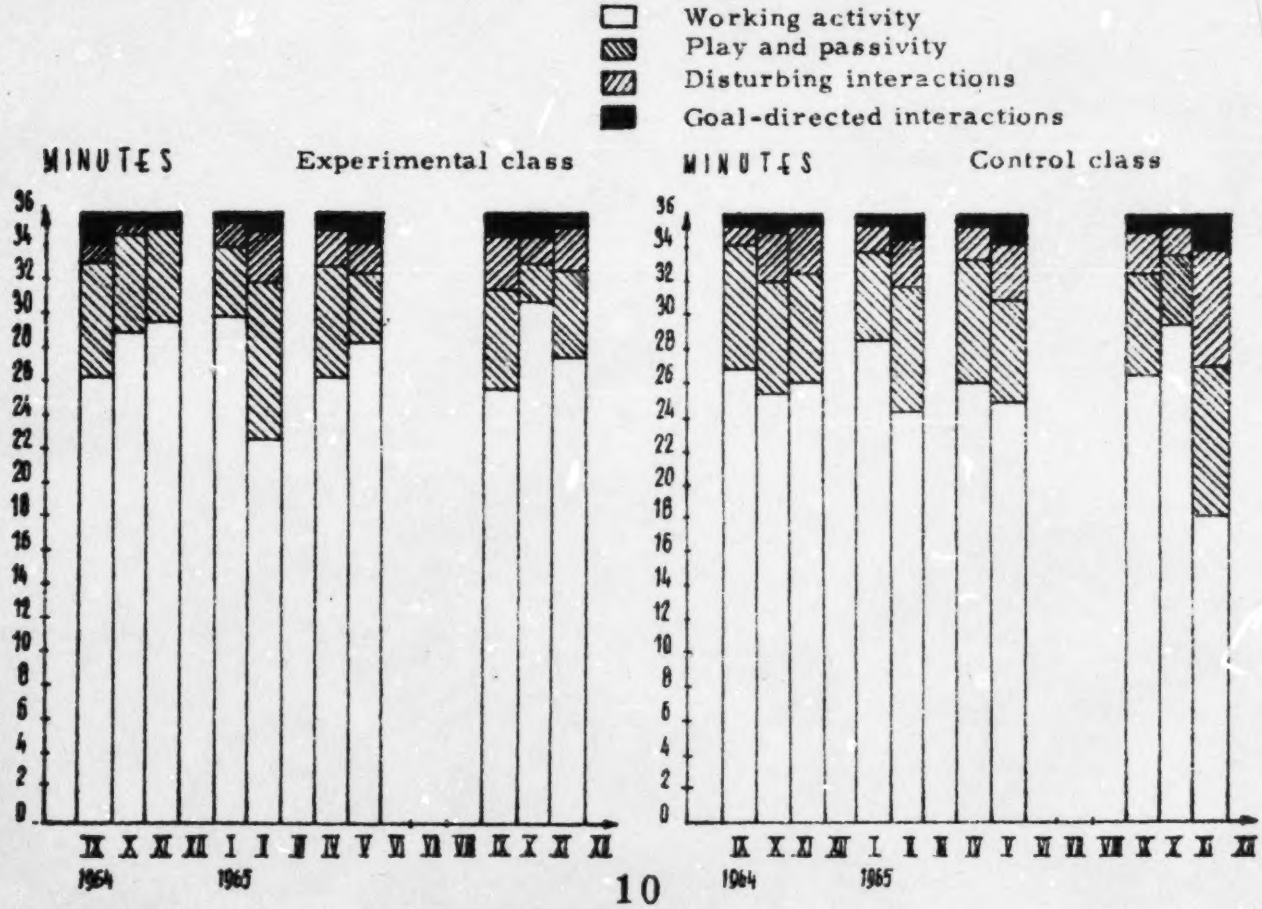


Fig. 6. Changes in "disturbing interactions".



In spite of the different teaching methods, classroom behavior is rather similar in both classes. A survey of the observations is given in Figure 7. The pupils are occupied by working activities in 70-80% of the arithmetic lessons, which we consider satisfactory.

Fig. 7. What the pupils do during the arithmetic lessons.

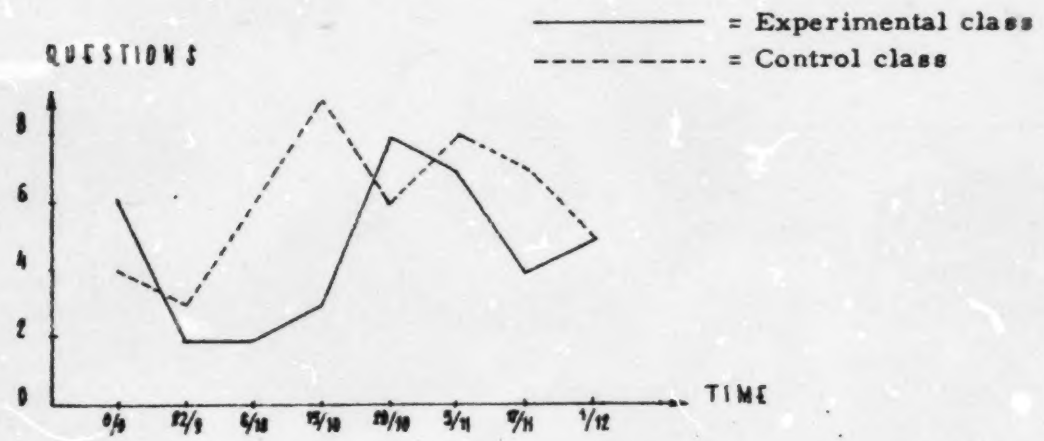


D. Analysis of working habits

When analysing pupils´ ability to read instructions (examined with a test by Werdelin), we found a significant improvement from grade seven to grade eight in the experimental class ($p < 0,005$; $n = 18$, $m_1 - m_2 = 2,11$). The permanent work with programmed material might be a contributory factor to that result. There was no significant improvement in the control class ($p > 0,20$; $n = 18$, $m_1 - m_2 = 1,11$). At the beginning of the experiment, there was no significant difference between the two classes; but after two semesters the experimental class is significantly superior in reading instructions. This result is a confirmation of teacher opinion: Pupils who receive programmed instruction are better able to read instructions and to independently manage their laboratory work.

The results of observations during the laboratory work in chemistry have been subjected to analysis of variance. The control class exceeds the experimental class in frequency of questions to the teacher (Fig. 8). However, the excess is not of such magnitude as to make the average frequency of such observations during the whole test period significantly more numerous than in the experimental class.

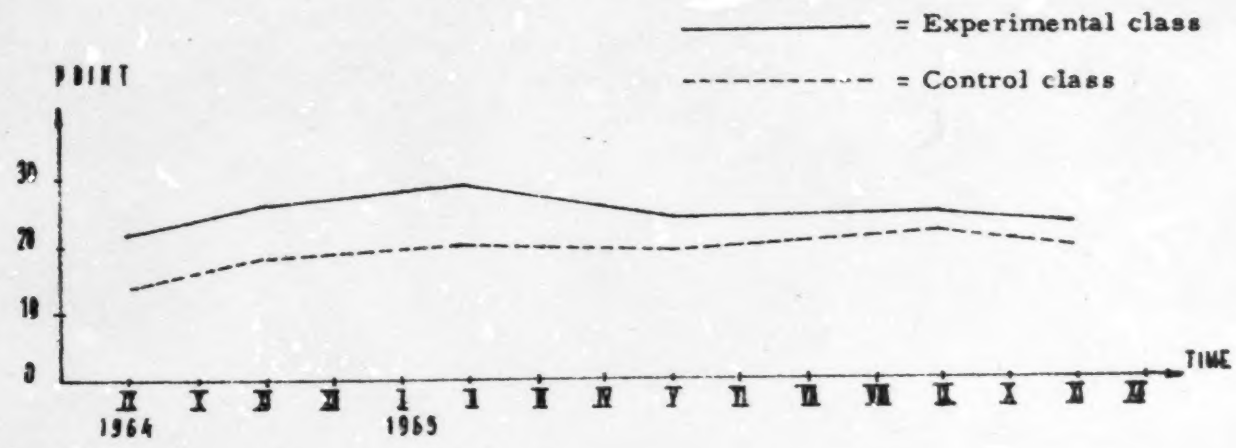
Fig. 8. Differences in frequency of questions.



E. Analysis of preference for arithmetic (Figure 9)

There are no significant differences in preference for arithmetic between the two classes; but the experimental class has a consistently higher average point during the whole experimental period which approaches significance.

Fig. 9. Changes in preference for arithmetic.



F. Survey of analysis of variance

Table 1 presents a survey of all analyses of variance.

Table 1. A survey of analyses of variance concerning arithmetic, preference, and behavior variables.

Variables \ Source of variation		Methods		Groups		Method x Group		Error a
		df	p	df	p	df	p	df
Arithmetic achievement		1	>0, 05	2	< 0. 001[y]	2	>0, 05	30
Reading ability		1	>0, 05	2	>0, 05	2	>0, 05	30
Preference for arithmetic		1	>0, 05	2	>0, 05	2	>0, 05	30
BEHAVIOR	Working activity	1	>0, 05	2	>0, 05	2	>0, 05	30
	Play and passivity	1	>0, 05	2	>0, 05	2	>0, 05	30
	Goal-directed interactions	1	>0, 05	2	>0, 05	2	>0, 05	30
	Disturbing inter-actions	1	< 0, 001[x]	2	>0, 05	2	>0, 05	30
	Working habits	1	>0, 05	2	>0, 05	2	>0, 05	30

Variables \ Source of variation		Trials		Method x Trial		Group x Trial		Method x group x trial		Error b	Total
		df	p	df	p	df	p	df	p	df	df
Arithmetic achievement		9	>0, 05	9	>0, 05	18	>0, 05	18	>0, 05	267	356
Reading ability		2	< 0, 001	2	< 0, 05	4	>0, 05	4	>0, 05	60	107
Preference for arithmetic		5	< 0, 005	5	>0, 05	10	>0, 05	10	>0, 05	150	215
BEHAVIOR	Working activity	9	< 0, 001	9	< 0, 01	18	>0, 05	18	>0, 05	263	352
	Play and passivity	9	< 0, 0005	9	>0, 05	18	>0, 05	18	>0, 05	263	352
	Goal-directed interactions	9	< 0, 001	9	>0, 05	18	>0, 05	18	>0, 05	263	352
	Disturbing inter-actions	9	< 0, 001	9	< 0, 001	18	>0, 05	18	>0, 05	263	352
	Working habits	7	>0, 05	7	>0, 05	14	>0, 05	14	>0, 05	199	276

[x] The control class has most notes.

[y] The high groups score higher.

G. Changes in attitudes toward programmed instruction

After instruction with teaching machines for one semester, 59% of the pupils were of the opinion that they had learned more arithmetic or as much as would have been possible through conventional instruction; and after three semesters 67% found that they learned more. In grade seven most pupils found machine instruction interesting, but in grade eight most pupils thought the method dull. The first semester fifty percent of the pupils working with the machines were of the opinion that they became more tired from working with programmed material; and after three semesters 73% found programmed instruction more tiring. In reply to the question "Would you like programmed instruction in arithmetic next semester?" 55% said no in both grade seven and grade eight. Most pupils preferred variation between teaching methods.

VI. SUMMARY AND CONCLUSIONS

In the present investigation, using a modified form of programmed instruction, we obtained certain results similar to those in an earlier study (Holmberg, 1965): There were no significant differences in achievement or preferences for the subject.

Classroom behavior was rather similar in the two classes, but there were significantly more observations noted for the control class in the variable "disturbing interactions".

A changed reading technique - the pupils had decreased their reading speed but gained in comprehension - yields a positive result as regards working habits. After two semesters the experimental class is significantly superior in reading instructions and tends to manage laboratory work more independently.

The attitude toward programmed instruction was not so positive in grade 8 as in grade 7, mostly depending on the pupils' finding P1 more tiring than C1. Nevertheless, their opinion is that they learn more arithmetic by the programmed method. Perhaps we should change method more often to get a more motivating school situation. We must continue our search for the optimal conditions for the use of programmed instruction in education.

The science of programming has been a stimulant in education. A greater effort will be devoted to developing instructional materials. To the teacher participating in this new experimental approach, programs and teaching machines have brought a new role. He distributes the programs, controls pupils' work and ascertains which pupils he can bring together in a group for small group instruction. Another new aspect of his work is the machine repair. When using programmed material the pupils experience a new school situation, too. They have to be alert and active all the time, read frames, write answers and control answers. - The basis for consistent improvement in educational methods is a systematic translation of experimental findings. It seems advisable that we should plan for significant revisions in concepts of classroom practices and teacher functions.

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